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ABSTRACT

This study tests the following hypotheses: (a) the ability to solve disjunctive concepts increases with age; (b) positive instances are of greater use in solving conjunctive concepts while negative instances are of greater use in solving disjunctive concepts; (c) older children will show greater improvement than younger children in concept attainment performance as the proportion of negative instances increases in a disjunctive problem. The subjects were 36 second grade children and 36 fifth grade children. The stimuli consisted of 32 cards on which there were geometric forms varying on five binary dimensions. Subjects pointed out those cards in the array which they felt best met the examiner's verbal description. Results indicate that second and fifth grade children solved disjunctive and conjunctive concept attainment problems with either 20%, 50%, or 80% positive instances. The older children solved conjunctive concepts more easily than disjunctive concepts; both were equally difficult for the younger children. As the proportion of negative instances increased, disjunctive concepts were solved more easily. (Author/WY)

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RULE STRUCTURE AND PROPORTION OF POSITIVE INSTANCES AS DETERMINANTS OF CONCEPT ATTAINMENT IN CHILDREN[1]

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One of the variables found to determine concept attainment performance is the logical structure of the classification rule. Adult Ss solve problems involving conjunctive concepts, which are based on the joint presence of two or more attributes, more easily than disjunctive concepts, which are based on the presence of one attribute or another one. (e.g., Bruner, Goodnow & Austin, 1956; Conant & Trabasso, 1964; Haygood & Bourne, 1965; Hunt & Hovland, 1960; Neisser & Weene, 1962; Schwartz, 1966; Wells, 1963).

Because of the relative inability of young children to solve logical problems (e.g., Inhelder and Piaget, 1958, 1964), it is reasonable to assume that there will be age-related increases in children's ability to solve problems which involve complex logical rule structures. Therefore, disjunctive concepts should be more difficult for children to solve than conjunctive concepts, since the latter involve simpler logical rules. Previous investigations of rule learning in children have been equivocal; King (1966) found that children have more difficulty learning disjunctive concepts than conjunctive concepts while Denney (1969) found that this was true only under certain instruction conditions. Di Vesta and Walls (1969) found that children learned conjunctive concepts more easily than disjunctive concepts, although the differences between the two types decreased sharply with practice. The purpose of the present study was to explore the relationship between concept attainment and rule complexity in children with the expectation that disjunctive concepts would be more difficult than conjunctive concepts for

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children, although this difference would diminish with increasing age as children gain greater facility in dealing with logical complexities.

It has been postulated that the solution of disjunctive concepts depends on the utilization of the information in negative instances and the solution of conjunctive concepts depends on the utilization of information on positive instances (Bruner, Goodnow, & Austin, 1956). Therefore, it can be expected that disjunctive concept attainment should become easier as the proportion of negative instances increases and, conversely, conjunctive concepts become easier as the proportion of positive instances increases. Since younger children have been found to have difficulty with negation (Inhelder & Piaget, 1958, 1964), it can be expected that they will be less able to utilize negative instances and thus benefit less from the information in them.

The present study was designed to test the following hypotheses: (a) the ability to solve disjunctive concepts increases with age; (b) positive instances are of greater use in solving conjunctive concepts while negative instances are of greater use in solving disjunctive concepts; (c) older children will show greater improvement than younger children in concept attainment performance as the proportion of negative instances increases in a disjunctive problem.

Method

Subjects: The Ss were 36 second grade and 36 fifth grade children from Christ the King School in Hamilton, Ontario. The Ss were from middle class families and were of average or above average intelligence. Each sub-group of the experiment had three girls and three boys.

Stimuli: The stimuli consisted of 32 cards on which there were geometric forms varying on five binary dimensions: color (blue or yellow), size (large or small), number (one or two), form (circle or triangle), and striations (absent or present). In addition to the actual stimulus cards, S had before him a diagram which depicted the total array of the 32 cards.

Tasks: E read the following instructions to S:

"I have some cards with different pictures on them. Here is a sheet which shows all the cards we will use. You can see that all the cards are different. This card is a picture of a triangle and this card is a picture of a circle. Some of the pictures are blue and some are yellow. Some of the pictures are big and some are small. Some cards have two pictures and other cards only one picture. Some are just plain and others are striped."

"We will call some of the cards A cards, and all of the A cards will be alike in some way."

If the subject was to receive a conjunctive concept the following instructions were read:

"For example all the A cards might be yellow and striped -- like this one or this one. Now you point to all the striped yellow pictures. Now show me some that are not striped yellow pictures. Another way all the A cards might be alike is that they are one triangle. You point to all the cards that are pictures of one triangle. Show me some pictures that are not one triangle. Do you have any questions?"

If S was to receive a disjunctive concept, the following instructions were read:

"For example, all the A cards might be yellow or striped like these. Can you show me some others that are striped or yellow? Now show me some pictures that are neither striped nor yellow. Another way all the A cards might be alike is that they are one or a triangle, like these. Show me some cards that have one picture or a picture of a triangle. Can you show me some cards that don't have one picture nor a triangle. Do you have any questions?"

Regardless of the concept condition the following instructions were then read:

"All of the A cards will be alike in two ways, just like in the examples".

"I will first show you a card that is an A card. Then I will show you some other cards, and I want you to tell me if they are A cards or not. Some cards will be A cards and some will not. I want you to guess whether the card is an A card and try and find out how all the A cards are alike. Do you have any questions?"

S was required to identify positive and negative instances of the particular concept in question correctly, as cards were presented sequentially to him. Once he had classified a particular instance, S was given immediate feedback about the correctness or incorrectness of his choice. If S made ten consecutive correct classification responses at any point, the sequence was terminated and he was considered to have solved the problem. If the criterion was not reached in 75 trials, the problem was terminated. At the end of each problem S was asked to identify the concept from a list of four choices, only one of which correctly designated the concept. These four choices contained only the type of concept used in the problem (conjunctive or disjunctive).

Design: The three major variables under study were: (a) concept type (conjunctive or disjunctive); (b) grade level (second or fifth); (c) proportion of positive and negative instances (20%, 50%, or 80%).

One-half of the Ss in each grade were given tasks involving conjunctive concepts, and the other half solved problems involving disjunctive concepts. Within each concept condition each S received three problems, each of which had 20%, 50%, or 80% positive instances. The percentage of positive instances were counterbalanced in three orders: 20 - 50 - 80, 50 - 80 - 20, and 80 - 20 - 50. Six Ss in each grade were administered each order in the conjunctive and disjunctive problems for a total of 36 Ss from each grade.

Results

The mean number of trials to reach criterion for all groups is shown in Figure 1. The conjunctive groups (C) receiving 80%, 50%, and 20% instances were assigned difficulty levels 1, 2, and 3 respectively and the disjunctive groups (D) receiving 20%, 50%, and 80% positive instances were assigned difficulty levels 1, 2, and 3 respectively. For the purposes of this analysis, it was assumed that the higher proportion of positive instances would increase the ease of conjunctive concept attainment while a lower proportion of positive instances (and thus, more negative instances) would make disjunctive concept attainment easier. A mixed design analysis of variance involving the variables of grade (second and fifth), concept type (conjunctive or disjunctive) and difficulty level (proportion of positive instances), was performed on the data. The results of this analysis are presented in Table 1. Although there were no significant effects of grade and of concept type, the grade x concept type interaction proved to be significant ($F = 5.4$, $df = 1, 68$ $p < .05$). Individual comparisons of the means indicated the grade 5 conjunctive group performed significantly better than the grade 5 disjunctive group ($p < .001$), but there was no difference between the conjunctive and disjunctive concepts for the second grade Ss.

The levels of difficulty were found to be significantly different from one another ($F = 73.60$, $df = 2, 136$ $p < .001$).

In addition to mean trials to criterion, the proportion of Ss identifying the concept was calculated for each concept group at both grade levels. These data are presented in Table 2. Examination of this table shows only one condition close to chance level, grade 5 C3 (.28); all others were significantly greater than chance.

The point bi-serial correlations between trials to criterion and ability to identify the concept correctly were -.55 for grade 2 - conjunctive ($p < .002$), -.51 for grade 5 conjunctive

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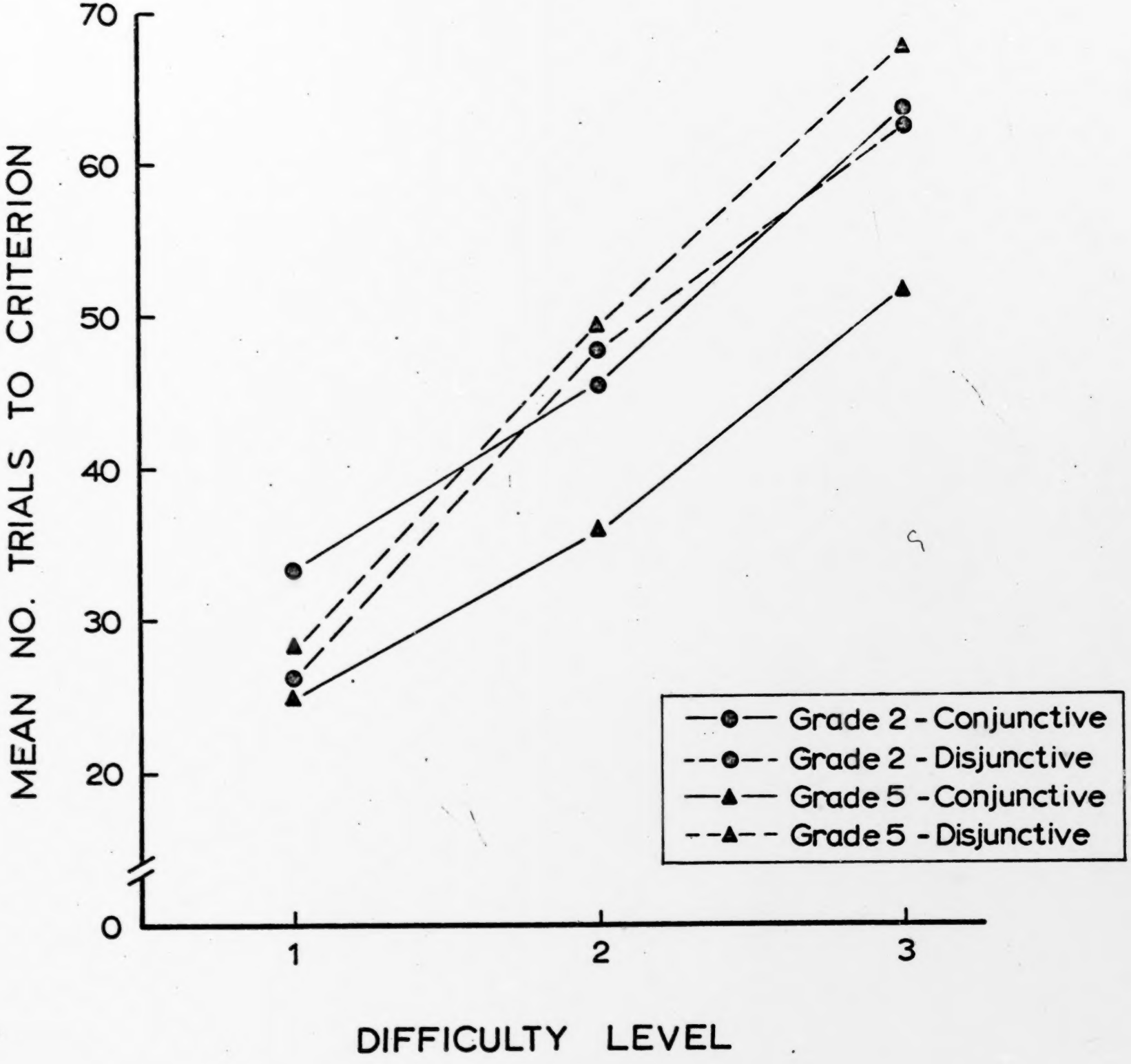

Fig. 1. Mean number of trials to criterion as a function of concept type, grade, and difficulty level (proportion of positive and negative instances).

TABLE 1

Analysis of Variance

SOURCE	df	MS	F
Total	215	--	--
Between Subjects	71	--	--
Grade (G)	1	647.57	1.53
Concept Type (C)	1	1157.41	2.74
(G x C)	1	2281.50	5.40*
Error	68	422.86	--
Within Subjects	144	--	
Difficulty Level (DL)	2	19867.26	73.60**
DL x G	2	5.42	1
DL x C	2	531.06	1.97
DL x G x C	2	46.85	1
Error	136	269.94	--

* p .05

** p .01

($p < .002$); -.29 grade 2 disjunctive ($p < .05$); and -.34 for grade 5 disjunctive ($p < .02$).

Conclusions

The significant interaction between grade level and type of concept is the result of the fact the fifth grade Ss performed better on conjunctive tasks than disjunctive tasks while second grade Ss did not differ significantly in their performance on these two types of concept tasks. The fifth grade Ss did no better on disjunctive tasks than the second grade Ss, but they did better than the second grade Ss on conjunctive tasks. These findings give only partial support to the hypothesis that conjunctive concepts are easier to attain than disjunctive concepts, and that older children should do better on both. Thus, rule complexity does not appear to be a significant determinant of developmental differences in concept attainment performance. The failure to find age related increase in ease of disjunction may result from the fact that it was a very difficult task for all the age groups. The difficulty in solving disjunctive concepts appears to be the result of difficulty in dealing with disjunction itself, rather than difficulty in processing the information in negative instances. The finding that both grades performed better on the D1 conditions than on the D2 or D3 conditions indicates that they can use negative instances to infirm and alter hypotheses. Thus, disjunction does not appear to be inherently more difficult than conjunction; the difference in performance between the two types depends on the kind of instances presented.

The difficulty levels, indicative of the number of positive instances, proved to be significant determinant of performance. The condition with the least information (C3,D3)

TABLE 2

Proportion of Ss Identifying the Concept

Level / Grade	C3	C2	C1	$\bar{X}$
2	.44	.50	1.0	.64
5	.28	.72	1.0	.66
$\bar{X}$	.36	.61	1.0	.65

D3	D2	D1	$\bar{X}$
.39	.61	.77	.59
.44	.66	.77	.62
.42	.64	.77	.61

showed the highest mean number of trials to criterion. The fact that no interaction effects were found indicates that this finding holds for both grade levels and both concept types. As a result, it can be concluded that increasing the proportion of positive instances increases the ease with which a conjunctive concept will be obtained, while increasing the proportion of negative instances increases the ease with which a disjunctive concept will be obtained and that both older and younger children can process the information in positive and negative instances equally well.

The proportion of Ss identifying each concept shows no significant difference between grades or levels of difficulty, indicating that all Ss can verbalize a concept equally well once it has been attained. The point bi-serial correlations indicate that the ability to verbalize the concept is related to the ease of concept attainment. These findings replicate those of Siegel (1969).

It is concluded, then, that older children do better on conjunctive tasks than younger children and that older children are better able to handle conjunction than disjunction problems. It is also concluded that positive instances are of more use in attaining conjunctive concepts, and negative instances are of more use in attaining disjunctive concepts.

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